

spray a patterned discontinuous layer of tackifier." See page 9, lines 13-15. Equally significant, tackifier resin is forced into the filaments of the fibers themselves. Again there is antecedent basis in that "[t]he patterned roller is positioned such that the contact of the patterned roller with the reinforcing fibers is sufficient to force some of the resin into the fibers themselves." See page 8, lines 23-25. While not specifically discussed in the application of the present invention, the significance of this "forcing" is readily apparent in the art. Applicant has provided to the Examiner relevant portions from two text sources, *ASM Handbook, Volume 21 Composites*, or hererinafter "ASM Handbook," a compilation prepared under the direction of the ASM International Handbook Committee, and *Composites Materials Handbook*, or hereinafter "Composite Handbook," authored by M. M. Schwartz. In the ASM Handbook, fibers, such as a carbon filament, contain "tiny undulating ribbon-like structures which are intertwined and oriented more or less parallel to the axis of the [filament]." See pages 36-37, Figure 2. Similarly in the Composite Handbook, polyacrylonitrile ("PAN") fibers "are offered as yarns containing 1,000 to 12,000 filaments and tows containing up to several hundred thousand filaments." See pages 2.42-2.43, Figure 2.8. These clarifying features of the present invention are not disclosed in the prior art as will be discussed in additional detail below.

Rejection under U.S.C. 102

The Examiner has rejected claims 1-3, 10-12, 14 and 18 under 35 U.S.C. 102(e) as being anticipated by United States Patent No. 6,096,669 issued to Colegrove, hereinafter "Colegrove".

The present invention as recited in independent claims 1 and 18 is directed to a method for preparing a preform. The method includes forming a layer of reinforcing fibers and applying a patterned discontinuous *liquid* layer of tackifier resin to at least one side of the layer of reinforcing fibers. A predetermined quantity of the tackifier resin is forced into a number of fibers. Finally the tackifier resin is cured.

The Examiner rejected claim 1 stating:

Colegrove discloses aligning fibers in order to form at least one layer (col. 3, lines 62-65). Next a resin grid film on release paper is applied to one or both sides of the fibers (Figure 3). The resin, which is polymeric curable, is in the form of grid such that only a fraction of the surface area of the fibers contact the curable resin film grid (discontinuous layer) (Figures 1-3 and col. 2, lines 50-67 and col. 3, lines 41-58). PR500® may be used as a

resin in combination with PT500® epoxy resin, which is a powdered tackifier (col. 3, lines 32-42).

Applicant respectfully traverses this rejection. As amended, Colegrove does not anticipate a method of preparing a preform for a RTM molding process comprising the steps of: forming a layer of reinforcing fibers; applying a patterned discontinuous *liquid* layer of a tackifier resin to at least one side of the layer of reinforcing fibers, wherein a predetermined quantity of the tackifier resin being forced into a number of the fibers; and curing the tackifier resin.

Colegrove, as understood, discloses a method of applying a resin film grid from *a release paper* to each side of a unidirectional layer of fibers. Opposed heated rollers 14 are spaced apart to apply "sufficient pressure for the layers of resin film grid 8 (softened by the heated rollers) to *be transferred* to both sides of the unidirectionally aligned fibers 10." *See* col. 4, lines 9-12. The fibers then pass over a heated platen 15 to *melt the resin on the fibers*, resulting in a unidirectional fiber tape. The fiber tape is then passed through a pair of "nip" rollers which removes one of the release papers prior to rolling the fiber tape onto a take-up roller. As noted by the Examiner, Colegrove discloses and is limited to a method of applying a film grid from a *release paper*. Colegrove further states that the resin is structured "to achieve a viscosity desirable for printing the resin mesh film onto paper." *See* col. 2, lines 62-65. Therefore, Applicant's further clarification in claim 1 that the tackifier resin is applied in a patterned discontinuous *liquid* layer clearly differentiates Applicant's invention from Colegrove. Applicant has antecedent basis for this construction. *See* page 3, lines 26-27. Additionally, the Examiner stated in his Response to Arguments dated May 6, 2002:

The fact that Colegrove uses multiple fiber layers while the applicant uses a single layer does not make the invention patentably distinct over Colegrove. In addition Colegrove states that the resin transfer molding process can be applied to "one or more layers of non-woven random mat." The examiner takes the position that "one or more" includes a single fiber layer (col. 1, lines 50-55).

Applicant notes that the Examiner failed to complete his own citation of Colegrove in that Colegrove:

is a preform suitable for use in a resin transfer molding process comprising
(1) one or more layers of a non-woven random mat made of chopped

fibers and (2) one or more layers of a series of tows of unidirectional fibers held together by a film of polymeric curable resin.

See col. 1, lines 50-55. Taken in its full and proper context, Colegrove is disclosed and intended for molding *multiple* layers wherein the resin holds the layers together, and indeed, is patentably distinct from the present invention.

The Examiner further stated in his Response to Arguments dated May 6, 2002:

Applicant argues that in Colegrove an elevated pressure and temperature are used to transfer resin film grid onto a fiber mat whereas in the instant invention the resin is "forced" into the fibers. Applicant also states that the Colegrove reference states that multiple resin grids are being transferred to multiple layers whereas in the present invention resin is being forced onto a single layer of fibers. The examiner also notes that the applicant has amended the claim to recite the additional limitation "wherein a predetermined quantity of tackifier resin being forced into a number of fibers."

To respond to these arguments, the examiner takes the position that since Colegrove applies the resin film grid by using a release paper at an elevated temperature it is inherent that this process forces the resin into the fibers. In addition the resin film grid has a predetermined quantity of resin that is applied to the fibers, the resin is not free flowing (col. 4, lines 1-51).

Applicant respectfully traverses the Examiner's position regarding Colegrove inherently forcing resin into the fibers. As previously stated above, Colegrove discloses sufficient pressure so that softened resin film grid (by heated rollers) contained on release paper is merely *transferred* to both sides of the unidirectionally aligned fibers. Colegrove differs from the present invention in that the present invention transfers liquid resin to a fiber layer. Since the resin is *applied* in the liquid state in the present invention, the presence of sufficient pressure is employed "to force some of the resin into the fibers themselves." See page 8, lines 24-25. It is further noted that depending upon the type of resin used in the present invention, heat may not be required at all in the entire process since both resin application and curing may be achieved without heat. Nevertheless the resin is applied as a liquid.

It is preferable to use resins that are liquid at room temperature; however, resins that become liquid at elevated temperature may also be used. In the case of the latter, a heated resin supply 14 and heated supply roller 20 would be used.

See page 8, lines 1-3.

After application of the tackifier, the layer of reinforcing fibers is passed through a curing or setting stage 10 to cause the resin to turn into a solid flexible coating. This curing or setting process may be, for example, *cooling*, for example, air cooling in the case of tackifier applied at an elevated temperature, or exposure to a predetermined wavelength of EM radiation in the case of light initiated tackifier. The tackifier may undergo a self-curing process after application. Alternatively, for tackifiers that are aqueous dispersions, the tackifier-containing layer may be passed through a water evaporation process.

See page 8, lines 28-29, page 9, lines 1-6.

In contrast as discussed above, Colegrove must employ heat and pressure simply to help remove the resin layer from the release paper, the resin layer necessarily being in *solid* form since it is attached to release paper. The fibers in Colegrove then pass over a heated platen 15 to *melt the resin on the fibers*. In an alternate embodiment of Colegrove, *multiple* layers of non-woven random mat and unidirectional fiber tape are *adhered together* employing a heated pressurized sled. See col. 4, lines 40-44. Colegrove does not disclose forcing resin into the fiber layers. In fact, forcing resin into the layers appears to be contrary to one of the teachings of Colegrove, which is to leave the resulting preform porous. See Colegrove at col. 3, lines 45-47 and col. 2, lines 3-5. Since there is no disclosure regarding resin being forced into the fiber layers, but rather a teaching to the contrary, much less disclosing forcing resin into the fiber filaments themselves as previously discussed in the present invention, and further, because there are multiple layers of resin on opposite sides of the resin layer, unlike the single layer disclosed in the present invention, the presence of heat and pressure in Colegrove are likely similar to that required in the preferred embodiment, that is, to melt the resin *on the fibers*, and the extent of pressure is merely to bring the adjacent fiber layers into contact to enhance adhesion therebetween which is consistent with maintaining the resulting preform porous for subsequent operations. As such, Applicant asserts that not only is it *not* inherent that the Colegrove process forces resin into the fibers, but since the disclosure requires the preform to be porous and in the preferred embodiment fail to indicate forcing resin into the fibers, or even between the fibers, to make such an assumption requires knowledge of the present invention and impermissible hindsight. Further, due to the Colegrove process only disclosing multiple layers of resin and a porous preform, Colegrove necessarily cannot teach what the Examiner maintains. Thus, for the

reasons listed above, Applicant respectfully submits that Colegrove cannot anticipate claim 1 of the present invention.

The Examiner rejected claim 2 stating:

With regard to claim 2, Colegrove shows that the patterned discontinuous layer of tackifier resin is applied by a patterned roller (col. 2, lines 41-57).

Applicant respectfully traverses the Examiner's rejection. Colegrove discloses an imprint roller 7 in contact with a rotating roller 4 which forms a resin film grid 8 on release paper. *See* col. 2, lines 45-53. However, the film grid is applied to the fibers *by the release paper*. *See* col. 4, lines 9-12. In contrast, the present invention does not require release paper, and as claim 1 is amended to directly apply a patterned discontinuous *liquid* layer of tackified resin, claim 2 not only lacks release paper, but is necessarily *incompatible* with release paper. Because Colegrove includes an element not present in the claims as amended Colegrove cannot anticipate claim 2.

Inasmuch as claim 2 is dependent on claim 1 providing but an additional limitation to this claim, which is believed to be allowable as discussed above, claim 2 is also believed to be allowable.

Therefore for the reasons given above, dependent claim 2 is believed to be distinguishable from Colegrove and therefore is not anticipated by Colegrove.

The Examiner rejected claim 3 stating:

With regard to claim 3, tackifier resin is applied by a release paper (Figure 2 and col. 2, lines 47-53).

In response thereto, Applicant cancels, without prejudice, claim 3. Therefore, the rejection is believed moot.

The Examiner rejected claim 10 stating:

With regard to claim 10, although Colegrove does not expressly recite that the tackifier resin is forced into the fibers one in the art would expect this to occur in order for the reinforcing fibers to be held together.

In response thereto, Applicant had previously canceled claim 10. However, Applicant has added claim 19 which is essentially claim 10 with the added clarification that the tackifier resin is being forced into a number of fibers *as the tackifier resin is applied*. Assuming,

arguendo, that Colegrove teaches forcing resin into fibers, which it does not as discussed above, such "forcing" only occurs *after* the tackifier resin has been transferred onto the fibers. That is, the purpose of heated rollers 14 is to *transfer the softened film grid 8 onto both sides of fibers 10.* See col. 4, lines 9-12. Similarly, heated rollers 22, which are not disclosed to operate differently from rollers 14, must operate the same as rollers 14. Pressure sled 24 and heated platen 23, which operate to adhere random tape 20 to unidirectional fiber tape 16, only occurs *after the tackifier resin has been applied.* See col. 4, lines 39-44. However, for reasons previously discussed, including Colegrove being limited to joining multiple fiber layers and utilizing solidified resin from release paper to join adjacent fiber layers, one in the art would *not expect*, especially without a specific teaching in Colegrove to indicate that resin is forced into the fibers as discussed above, which is conspicuously absent from Colegrove. Absent such a teaching the Examiner can only reach this conclusion by impermissible hindsight. Thus, Colegrove cannot anticipate claim 19 by Colegrove.

Inasmuch as claim 19 is dependent on claim 1 providing but an additional limitation to this claim, which is believed to be allowable as discussed above, claim 19 is also believed to be allowable.

Therefore for the reasons given above, dependent claim 19 is believed to be distinguishable from Colegrove and therefore is not anticipated nor rendered obvious by Colegrove.

The Examiner rejected claims 11-12 over Colegrove.

Inasmuch as claims 11-12 are dependent on claim 1 providing but an additional limitation to this claim, which is believed to be allowable as discussed above, claims 11-12 are also believed to be allowable.

The Examiner rejected claim 14 stating:

With regard to claim 14, Colegrove produces a preform using the process of claim 1 of the instant invention (Colegrove, Abstract and Figure 5).

Applicant respectfully traverses the Examiner's rejection since Colegrove does not anticipate nor render obvious claim 1, from which claim 14 depends. In other words, dependent claim 14 recites further limitation that distinguishes over the applied art.

Inasmuch as claim 14 is dependent on claim 1 providing but an additional limitation to this claim, which is believed to be allowable as discussed above, claim 14 is also believed to be allowable.

The Examiner rejected claim 18 stating:

With regard to claim 18, Colegrove discloses forming *a layer* of reinforcing fibers and applying a coating of tackifier curable-resin to at least one of the sides of the reinforcing fibers as noted above. Colegrove also goes on to say that after the tackifier resin is applied to the reinforcing fibers the individual plies may be shaped and the preform may then be molded. The preform is manufactured such that fibers have a resin content which is sufficient to hold the fibers in a desired shape but also small enough to leave the resulting preform porous so that it can be impregnated with matrix resin during subsequent molding processes (col. 1, lines 39-47 and col. 5, lines 49-59). One would expect this matrix resin to be in liquid form so it could penetrate through the pores of the preform. (emphasis added by Applicant)

Claim 18 has been amended to clarify that a patterned discontinuous *liquid* coating of adhesive tackifier resin is applied as previously discussed in claim 1. However as also previously discussed, and applicable here, Applicant submits that Colegrove discloses a method for joining *multiple* layers of fibers, not a single fiber layer as well as traversing the Examiner's contention that Colegrove teaches forcing resin into a number of fibers. Thus, Colegrove does not anticipate claim 18 of the present invention. Applicant's operation is achieved in one step, the application of the liquid tackifier resin, whereas Colegrove teaches a two-step process, application of the tackifier resin and impregnating the porous matrix with a second matrix resin. This is not Applicant's invention.

Therefore, for the reasons given above, Applicant submits that claims 1, 2, 10-12, 14 and 18 are not anticipated by Colegrove.

Rejection under 35 U.S.C. 103

The Examiner has rejected claims 7, 9 and 13 under 35 U.S.C. 103(a) as being unpatentable over Colegrove.

Claims 7, 9 and 13 depend from claim 1 which Applicant believes to be distinguishable from Colegrove for the reasons given above and include further limitations from Colegrove and are believed to be allowable for the reasons given above.

The Examiner has rejected claims 4-6 and 8 under 35 U.S.C. 103(a) as being unpatentable over Colegrove in view of United States Patent No. 5,480,603 issued to Lopez, hereinafter "Lopez," and United States Patent No. 2,207,279 issued to Alderfer, hereinafter "Alderfer."

The Examiner states:

With regard to claim 4, as noted above Lopez shows applying a discontinuous layer of tackifier resin using a spray nozzle and Alderfer discloses applying a resin in a patterned arrangement, wherein the resin is applied not as a film. At the time of the invention, it would have been obvious to one of ordinary skill in the art that the patterned resin used in Colegrove could have been applied using a spray nozzle as is shown by Lopez in view of Alderfer (Lopez, col. 7, lines 48-53, Alderfer, col. 2, lines 17-55).

Applicant respectfully traverses this rejection. The discussion of Colegrove above is equally applicable to this rejection. As previously discussed in Applicant's response to the Examiner's action dated May 6, 2002, Lopez does not *apply* a discontinuous layer of tackifier resin using a spray nozzle, and Alderfer is non-analogous art and improper for the Examiner to cite alone or in combination with other references against any of the claims of the present invention.

Lopez, as understood, utilizes an aqueous dispersion which *substantially uniformly distributes* the tackifier. (*emphasis added*) It is upon the removal of water from the dispersion that the discontinuous film coating is achieved. As stated in one of the embodiments:

A visual examination of the dried coated plies reveals a substantially uniformly distributed discontinuous film coating of the tackifier on their surfaces.

See col. 7, lines 56-59. Applicant asserts that Lopez *applies* a substantially uniform layer of tackifier in aqueous dispersion, such as by a spray nozzle. This is not the present invention. Lopez does not teach or suggest a "patterned" discontinuous layer. While Lopez discusses a *resulting* discontinuous layer, after drying of the aqueous dispersion of tackifier, Lopez does not

discuss a "patterned" discontinuous layer. The Examiner makes reference to a "random pattern" in the action dated May 6, 2002, but does not explain the meaning of "random pattern."

Applicant does not understand how a coating can be considered random and having a pattern at the same time. The formation of the discontinuous coating as a result of a drying process prevents the formation of a pattern because discontinuities cannot be controlled. Thus, for the reasons given above, Lopez does not teach or suggest the *application* of a discontinuous layer of tackifier resin using a spray nozzle, and in fact teaches away from the present invention. Nor is there a suggestion to combine Lopez with Colegrove. As such, Lopez cannot, either alone or in combination with other references, render obvious claim 4 of the present invention.

Alderfer, as understood, discloses a method for making cord fabric for use with pneumatic tires. A roll of adjacent parallel strands of cord fabric are secured in position by application of viscous material to one surface of the fabric. The viscous material is allowed to dry on the fabric surface prior to being wound on a take-up roll forming a fabric strip. Alderfer further discloses:

In the rubber industry the fabric may be impregnated with rubber composition and then coated with unvulcanized rubber in a calender as is well known in the art. It is then bias-cut into smaller pieces of proper length and width and built into the carcasses of pneumatic tire casings.

See Alderfer col. 3, lines 8-12. Figs. 3 and 4 illustrate a tire casing before vulcanizing and after vulcanizing, respectively. *See* col. 3, lines 14-19.

Alderfer does not disclose an RTM process. RTM, which is an acronym for resin transfer molding, is defined in Applicant's specification as follows:

Layers of reinforcing material of a predetermined shape, known as preforms, are loaded into a mold, and a thermosetting or EM wavelength activated resin binder is injected into the mold and cured by known procedures to provide a finished part.

See Applicant's specification page 1, lines 16-20. Alderfer fails to disclose any type of injection operation, much less such an operation occurring once the preforms are loaded into a mold. More specifically, the impregnation of fabric and coating with unvulcanized rubber in a calender as is well known in the art is confined to the compressive effect provided by the calender. Since

Alderfer is not directed to an RTM molding process, it is non-analogous art and improper for the Examiner to cite Alderfer, either by itself or in combination with other references against any of the claims of the present invention. Further, the purpose for the coating (bond 11) in Alderfer was to secure adjacent cords together for subsequent processing; that is to create a weftless cord fabric without the cost normally associated therewith. *See* Alderfer col. 1, lines 18-24 and Fig. 1. Since the fibers in the present invention irrespective of the type (uni-directional, bi-directional and random) are already secured within the formed fiber layer prior to the application layer of tackifier, the application of coating in Alderfer is superfluous and teaches away from the present invention. Additionally, as contained in the Examiner's action dated October 21, 2002, Applicant's responses to all rejections under 35 U.S.C. 103(a) involving Lopez and Alderfer, including claim 4 was confirmed by the Examiner as being fully persuasive.

Furthermore, assuming for argument purposes only that Lopez and Alderfer are combinable, the Examiner has not provided any teaching or suggestion in either Lopez or Alderfer that would direct one skilled in the art to make such a combination. The Examiner has not cited any passage in Lopez teaching or suggesting the desirability of using a "patterned" coating nor has the Examiner cited any passage in Alderfer that would teach or suggest the desirability of using a discontinuous coating or an RTM molding process. Thus, since the Examiner has provided no teaching or suggestion for making the combination, Applicant submits that the Examiner has made the combination based on Applicant's own teaching, which is impermissible hindsight reasoning by the Examiner.

The Examiner states:

With regard to claim 5, the types of reinforcing fibers recited are well known, as evidenced in the prior art acknowledged in the specification. At the time of the invention, one of ordinary skill in the art would have used these types of fibers in order to provide to make a strong and durable composite material (Specification, page 6, lines 1-7).

With regard to claim 6, the types of reinforcing fibers recited are well known, as evidenced in the prior art acknowledged in the specification. At the time of the invention, one of ordinary skill in the art would have used these resins because of their strong tackifier and curing properties so that they would harden by the time the individual plies were

placed in the mold for the RTM process (Lopez, col. 2, lines 61-65 and Specification (Instant Application), Page 7, lines 17-18).

With regard to claim 8, Lopez recites the volume percentages of the tackifier resin (col. 4, lines 1-14).

Claims 5, 6 and 8 depend from claim 1 which Applicant believes to be distinguishable from Colegrove for the reasons given above and include further limitations from Colegrove and are believed to be allowable for the reasons given above. Further, as contained in the Examiner's action dated October 21, 2002, Applicant's responses to all rejections under 35 U.S.C. 103(a) involving Lopez and Alderfer, including claims 6 and 8 were confirmed by the Examiner as being fully persuasive.

Applicants assert that neither Colegrove, Lopez or Alderfer either alone or in combination recognize the advantage of a method of preparing a preform for a RTM molding process comprising the steps of: forming a layer of reinforcing fibers; applying a patterned discontinuous *liquid* layer of a tackifier resin to at least one side of the layer of reinforcing fibers, wherein a predetermined quantity of the tackifier resin being forced into a number of the fibers; and curing the tackifier resin. The combination of the three, lacking any motivation to employ a patterned discontinuous liquid layer of tackified resin as taught by Applicant, would not yield Applicant's invention. It is clear that the Examiner can arrive at this combination to achieve Applicant's invention only after exposure to Applicant's invention. In the absence of this motivation or suggestion, Applicant submits that the combination of Colegrove, Lopez or Alderfer to achieve Applicant's invention can only be reached by use of impermissible hindsight. The references must be used without the benefit of hindsight afforded by the claimed invention.

Therefore, for the reasons given above, Applicant submits that claims 4-9 and 13 are not rendered obvious over Colegrove or any combination of Colegrove, Lopez and Alderfer.

CONCLUSION

In view of the above, Applicant submits claims 1, 2, 4-9, 11-14 and 18-19 are not anticipated nor rendered obvious in view of Lopez, Alderfer, Colegrove or any combination thereof. Thus, Applicant requests the withdrawal of the outstanding objections and rejections and allowance of claims and issuance of the application. A timely and favorable action is earnestly solicited.

Should the Examiner have any questions with respect to any matter now of record, the Examiner is requested to contact the undersigned at the phone number listed below.

Respectfully submitted

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MARKED UP VERSION OF THE CLAIMS

1. **(Twice Amended)** A method of preparing a preform for a RTM molding process comprising the steps of:
 - forming a layer of reinforcing fibers;
 - applying a patterned discontinuous liquid layer of a tackifier resin to at least one side of the layer of reinforcing fibers, wherein a predetermined quantity of the tackifier resin being forced into a number of the fibers; and
 - curing the tackifier resin.
18. **(Twice Amended)** A method of preparing a fiber-reinforced composite article for use in a gas turbine engine, comprising the steps of:
 - forming a layer of reinforcing fibers;
 - applying a patterned discontinuous liquid layer of adhesive tackifier resin in a predetermined amount to at least one side of the layer of reinforcing fibers to form a tacky ply, wherein a portion of the predetermined amount of the tackifier resin being forced into a number of the fibers;
 - assembling a plurality of the plies to form a preform, the predetermined amount of adhesive tackifier resin being sufficient to maintain the assembled plies in a shape of the preform;
 - placing the preform in a mold; then
 - injecting a second resin in liquid form into the mold to form a continuous matrix of resin between and around the plies of the preform; and
 - curing the preform to form a near net shape article.